B.Tech (Honors) in Artificial Intelligence
Semester: 8th

1. **Course Title: Deep Learning**

Course Objectives

1. To understand the theoretical foundations and principles of deep learning algorithms and their applications.
2. To explore different architectures of neural networks such as CNNs, RNNs, and GANs.
3. To apply deep learning techniques to solve real-world problems such as image recognition, natural language processing, and speech processing.
4. To gain hands-on experience in implementing deep learning models using popular frameworks like TensorFlow and PyTorch.
5. To analyze and optimize deep learning models for better performance and efficiency.

Syllabus

Unit I: Introduction to Deep Learning
Basics of Artificial Neural Networks (ANN), activation functions (ReLU, Sigmoid, Tanh), forward propagation, backpropagation, gradient descent, optimization techniques (SGD, Adam, RMSprop), introduction to deep learning frameworks (TensorFlow, PyTorch).

Unit II: Convolutional Neural Networks (CNNs)
Architecture of CNNs (convolution layers, pooling layers, fully connected layers), applications in image classification and object detection, advanced CNN architectures (AlexNet, VGGNet, ResNet, InceptionNet), transfer learning, fine-tuning.

Unit III: Recurrent Neural Networks (RNNs) and Sequence Models
Introduction to RNNs (architecture, backpropagation through time), Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU), applications in time-series analysis, natural language processing (NLP), attention mechanisms, transformers.

Unit IV: Generative Models
Autoencoders, variational autoencoders (VAEs), generative adversarial networks (GANs) including architecture and training, applications in image generation and style transfer, challenges in training GANs.

Unit V: Model Optimization and Deployment
Hyperparameter tuning, regularization techniques (dropout, batch normalization), explainability in deep learning models, model deployment (exporting models to cloud and edge devices), ethics and challenges in deep learning applications.

Course Outcomes

1. Explain the core concepts and techniques of deep learning and its various architectures.
2. Design and implement Convolutional Neural Networks (CNNs) for image-based applications.
3. Develop and analyze Recurrent Neural Networks (RNNs) for sequence prediction tasks.
4. Utilize generative models like GANs and VAEs for creating innovative solutions.
5. Optimize, evaluate, and deploy deep learning models in practical scenarios.

Textbooks

1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, published by MIT Press, 2016.
2. "Neural Networks and Deep Learning: A Textbook" by Charu C. Aggarwal, published by Springer, 2018.

Reference Books

1. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron, published by O'Reilly Media, 2022.
2. "Deep Learning with Python" by François Chollet, published by Manning Publications, 2018.
3. "Deep Reinforcement Learning Hands-On" by Maxim Lapan, published by Packt Publishing, 2020.

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2.Course Title: Cloud Computing

Course Objectives

1. To understand the fundamental principles, architecture, and models of cloud computing.
2. To explore cloud service models, virtualization techniques, and cloud resource management.
3. To analyze and implement cloud storage, computing, and networking solutions.
4. To investigate security, privacy, and compliance issues in cloud environments.
5. To gain practical experience in deploying and managing cloud-based applications using industry-relevant platforms.

Syllabus

Unit I: Fundamentals of Cloud Computing
Introduction to cloud computing, evolution and characteristics of cloud computing, service models (IaaS, PaaS, SaaS), deployment models (public, private, hybrid, community), advantages and challenges of cloud computing, architecture and reference models, applications of cloud computing in AI and data science.

Unit II: Virtualization and Resource Management
Concepts of virtualization, types of virtualization (hardware, network, storage), hypervisors, virtual machine provisioning and migration, resource allocation and scheduling, elasticity and scalability in cloud computing, case studies on virtualization technologies.

Unit III: Cloud Storage and Networking
Cloud storage architecture, distributed file systems, storage management and data replication, cloud-based data management systems, cloud networking basics, software-defined networking (SDN) in the cloud, content delivery networks (CDNs), examples of cloud storage services (Amazon S3, Google Cloud Storage).

Unit IV: Cloud Security and Privacy
Introduction to cloud security, threats and vulnerabilities in the cloud, data protection techniques, identity and access management (IAM), regulatory compliance in cloud computing, intrusion detection and prevention in cloud environments, case studies on cloud security breaches.

Unit V: Cloud Platforms and Applications
Overview of popular cloud platforms (AWS, Google Cloud Platform, Microsoft Azure), building and deploying cloud-based applications, serverless computing, containerization using Docker and Kubernetes, cloud cost optimization strategies, applications of cloud computing in AI and machine learning.

Course Outcomes

1. Explain the core principles, service models, and deployment models of cloud computing.
2. Demonstrate the use of virtualization technologies and resource management techniques in cloud environments.
3. Design and manage cloud storage and networking solutions for real-world applications.
4. Evaluate cloud security mechanisms and implement data protection strategies.
5. Develop and deploy cloud-based applications using modern platforms and tools.

Textbooks

1. "Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, published by Pearson Education, 2013.
2. "Cloud Computing for Dummies" by Judith Hurwitz, Robin Bloor, Marcia Kaufman, and Fern Halper, published by Wiley, 2010.

Reference Books

1. "Cloud Computing: Principles and Paradigms" by Rajkumar Buyya, James Broberg, and Andrzej Goscinski, published by Wiley, 2011.
2. "Mastering Cloud Computing" by Rajkumar Buyya, Christian Vecchiola, and S. Thamarai Selvi, published by McGraw Hill Education, 2013.
3. "Cloud Security: A Comprehensive Guide to Secure Cloud Computing" by Ronald L. Krutz and Russell Dean Vines, published by Wiley, 2010.

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Professional Elective III (Table I)

Professional Elective-1: **Applied Graph Theory**

Course Objectives

1. To understand the basic principles and terminologies of graph theory and their relevance to artificial intelligence and data science.
2. To analyze graph structures and apply traversal algorithms for solving computational problems.
3. To study optimization and matching techniques in graphs for applications like network design and resource allocation.
4. To explore advanced topics such as spectral graph theory and knowledge graphs to solve complex AI challenges.
5. To apply graph-theoretical methods to model and solve real-world problems in social networks, transportation, and machine learning.

Syllabus

Unit I: Introduction to Graph Theory
Basic terminologies: vertices, edges, degree, adjacency, types of graphs (simple, directed, weighted, multigraph, bipartite), graph representations (matrix, adjacency list), subgraphs, isomorphism, Eulerian and Hamiltonian paths, applications of graph theory in AI and data structures.

Unit II: Graph Traversals and Connectivity
Depth-first search (DFS), breadth-first search (BFS), connected components, strongly connected components, shortest path algorithms (Dijkstra's, Bellman-Ford), all-pairs shortest paths (Floyd-Warshall), minimum spanning trees (Prim's, Kruskal's), applications in routing and optimization.

Unit III: Matching and Covering in Graphs
Concept of matchings, maximum matching, bipartite graphs, Hall's theorem, vertex and edge covering, stable marriage problem, dominating sets, applications in scheduling, resource allocation, and clustering.

Unit IV: Network Flows and Graph Coloring
Max-flow min-cut theorem, Ford-Fulkerson algorithm, capacity scaling, graph coloring and chromatic numbers, planar graphs, applications in scheduling, map coloring, and transportation networks.

Unit V: Advanced Topics and Applications
Spectral graph theory, graph Laplacian, eigenvalues and their significance, random walks on graphs, introduction to knowledge graphs, applications in social network analysis, recommendation systems, and machine learning using graph embeddings.

Course Outcomes

1. Understand and apply fundamental graph theory concepts to model real-world problems in AI and data science.
2. Solve graph traversal and connectivity problems using efficient algorithms.
3. Design solutions for resource optimization and allocation using matching and covering techniques.
4. Analyze network flow problems and employ graph coloring in practical applications.
5. Leverage advanced graph-theoretical methods such as spectral graph theory and knowledge graphs for AI-driven insights.

Textbooks

1. "Introduction to Graph Theory" by Douglas B. West, Pearson Education, 2017.
2. "Graph Theory with Applications to Engineering and Computer Science" by Narsingh Deo, PHI Learning, 2004.

Reference Books

1. "Graph Theory" by Reinhard Diestel, Springer, 2017.
2. "Graphs, Networks and Algorithms" by Dieter Jungnickel, Springer, 2013.
3. "Discrete Mathematics and Its Applications" by Kenneth H. Rosen, McGraw Hill, 2012.

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Professional Elective-2: **Computational Geometry**

Course Objectives

1. To introduce the fundamental concepts of computational geometry and its applications in AI and data science.
2. To explore geometric algorithms for problem-solving in computer graphics, robotics, and data analysis.
3. To develop an understanding of convex hulls, Voronoi diagrams, and Delaunay triangulation.
4. To study algorithms for geometric optimization, including searching, intersection, and visibility problems.
5. To apply computational geometry techniques to solve real-world problems such as pathfinding, mesh generation, and spatial data analysis.

Syllabus

Unit I: Introduction to Computational Geometry
Overview of computational geometry, geometric objects and their properties, geometric transformations, types of geometric problems (searching, intersection, optimization), applications of computational geometry in AI, robotics, and graphics.
Unit II: Convex Hulls and Geometric Search
Convex hull algorithms (Graham's scan, Jarvis's march), properties of convex hulls, geometric searching, range searching, point location problems, binary space partitioning, applications in computer graphics, geometric databases, and mesh generation.
Unit III: Voronoi Diagrams and Delaunay Triangulations
Voronoi diagrams, properties and algorithms for constructing Voronoi diagrams, Delaunay triangulation and its properties, incremental algorithm for Delaunay triangulation, relationship between Voronoi diagrams and Delaunay triangulations, applications in terrain modeling, clustering, and nearest neighbor search.
Unit IV: Geometric Optimization
Line segment intersection, planar graphs, polygon triangulation, computational geometry in 3D, convexity testing, geometric optimization problems (e.g., facility location, closest pair of points), applications in robot motion planning and geographic information systems (GIS).

Unit V: Advanced Topics and Applications
Geometric intersection algorithms, visibility problems, geometric matching, algorithms for convex hulls in higher dimensions, mesh generation for finite element methods, computational geometry in AI-driven applications such as computer vision, autonomous systems, and spatial data analysis.

Course Outcomes

1. Understand the fundamental concepts of computational geometry and their importance in AI and data science applications.
2. Apply geometric algorithms to solve real-world problems in areas such as computer graphics, robotics, and geographic information systems.
3. Design and implement efficient algorithms for convex hulls, Voronoi diagrams, and Delaunay triangulations.
4. Solve geometric optimization problems related to searching, intersection, and visibility in computational geometry.
5. Apply advanced computational geometry techniques in 3D geometry, mesh generation, and spatial data analysis for AI and machine learning applications.

Textbooks

1. "Computational Geometry: Algorithms and Applications" by Mark de Berg, Otfried Cheong, Marc van Kreveld, and Mark Overmars, Springer, 2008.
2. "Computational Geometry: An Introduction" by Franco P. Preparata and Michael I. Shamos, Springer, 1985.

Reference Books

1. "Algorithm Design and Applications" by S. S. Ravi, CRC Press, 2012.
2. "Geometric Algorithms and Combinatorial Optimization" by Michel X. Goemans, David P. Williamson, Springer, 2004.
3. "The Geometry of Algorithms: From Discrete to Computational Geometry" by Tomaž D. Vojta, Springer, 2017.

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Professional Elective-3: **Explainable Artificial Intelligence (XAI)**

Course Objectives

1. To introduce the fundamental concepts of explainable AI (XAI) and its importance in building trust and transparency in machine learning models.
2. To explore techniques for making black-box models interpretable, including feature importance, model-agnostic methods, and local vs global explainability.
3. To study ethical considerations and challenges in AI decision-making processes and how explainability can mitigate biases.
4. To analyze popular XAI methods such as SHAP, LIME, and integrated gradients and their application to different AI models.
5. To develop the skills necessary to apply explainable AI techniques in various domains, such as healthcare, finance, and autonomous systems.

Syllabus

Unit I: Introduction to Explainable AI (XAI)
Overview of AI and machine learning models, need for explainability in AI, challenges in black-box models, importance of trust, interpretability vs explainability, ethical issues in AI, real-world applications of XAI.

Unit II: Explainability Techniques for Machine Learning Models
Feature importance methods, decision trees and rule-based systems for explainability, partial dependence plots, surrogate models, contrastive explanation, limitations of traditional methods.

Unit III: Model-Agnostic Methods for Interpretability
Introduction to model-agnostic techniques, LIME (Local Interpretable Model-Agnostic Explanations), SHAP (SHapley Additive exPlanations), Counterfactual Explanations, visualizing feature attribution, trade-offs between accuracy and explainability.

Unit IV: Deep Learning and XAI
Challenges of interpretability in deep learning models, layer-wise relevance propagation (LRP), integrated gradients, attention mechanisms for explainability in neural networks, explainability in convolutional neural networks (CNNs) and recurrent neural networks (RNNs).

Unit V: Applications of XAI and Ethical Considerations
XAI in healthcare (diagnosis, treatment recommendation), finance (credit scoring, fraud detection), autonomous systems (self-driving cars, robotics), fairness, transparency, and accountability in AI systems, regulatory frameworks, and ethical implications of XAI.

Course Outcomes

1. Understand the key concepts of explainable AI (XAI) and its role in improving model interpretability and trust.
2. Apply various techniques to make machine learning models interpretable and explainable, including both model-specific and model-agnostic methods.

3. Analyze and evaluate different XAI methods, such as LIME, SHAP, and integrated gradients, in terms of their effectiveness and limitations.
4. Address ethical and regulatory issues in AI decision-making processes and apply XAI techniques to mitigate biases.
5. Utilize explainable AI techniques to solve practical problems in domains like healthcare, finance, and autonomous systems, enhancing model transparency and accountability.

Textbooks

1. "Interpretable Machine Learning" by Christoph Molnar, Springer, 2020.
2. "Explainable AI: Interpreting, Explaining and Visualizing Deep Learning" by Ankur Taly, Shrikant Narasimhan, and Zico Kolter, Springer, 2021.

Reference Books

1. "Interpretable AI: A Guide to Explainable Machine Learning" by Patrick Hall, Navdeep Gill, and Kevin Zoller, O'Reilly Media, 2021.
2. "Hands-On Explainable AI (XAI): A Guide for Implementing Explainable AI Models" by Pradeep Gohil, Packt Publishing, 2021.
3. "Machine Learning Interpretability: A Guide for Practitioners" by Dan Shiebler, O'Reilly Media, 2020.

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Professional Elective-4: **Super Computing**

Course Objectives

1. To understand the fundamental concepts of supercomputing and its applications in solving complex AI and scientific problems.
2. To explore the architecture of supercomputers, including parallel processing, high-performance computing (HPC) systems, and distributed computing.
3. To study the algorithms and techniques used in supercomputing for solving large-scale problems in areas such as simulations, AI, and big data.
4. To learn about the performance evaluation of supercomputers, including metrics such as throughput, speedup, and scalability.
5. To develop the skills necessary to implement and optimize parallel algorithms and applications on supercomputing platforms for real-world problems.

Syllabus

Unit I: Introduction to Supercomputing
Overview of supercomputing, history and evolution of supercomputers, architecture of supercomputing systems, parallel and distributed computing, types of supercomputers (vector, scalar, hybrid systems), high-performance computing (HPC) clusters, applications in scientific computation and AI.

Unit II: Parallel and Distributed Computing
Parallel computing paradigms (data parallelism, task parallelism), parallel programming models (shared memory, distributed memory), message-passing interface (MPI), OpenMP, GPU computing, architecture of modern multi-core processors, fault tolerance, load balancing, synchronization, and scheduling.

Unit III: Supercomputing Algorithms
Algorithms for parallel processing, divide and conquer strategies, parallel sorting algorithms, matrix multiplication, Fast Fourier Transform (FFT), Monte Carlo simulations, optimization algorithms, machine learning algorithms for parallel processing.

Unit IV: Performance Analysis and Scalability
Performance metrics (speedup, efficiency, scalability, throughput), benchmarking supercomputers, Amdahl’s law and Gustafson’s law, bottleneck analysis, computational fluid dynamics (CFD) simulations, scalability of parallel systems, case studies of real-world supercomputing applications.

Unit V: Applications and Future Directions of Supercomputing
Supercomputing applications in AI, big data analytics, bioinformatics, weather forecasting, drug discovery, climate modeling, computational physics, quantum computing, the future of supercomputing (exascale computing, quantum supercomputing), trends in HPC infrastructure.

Course Outcomes

1. Understand the fundamental concepts, architectures, and applications of supercomputing in AI and scientific domains.
2. Analyze and apply parallel and distributed computing techniques to optimize the performance of supercomputing systems.
3. Develop and implement parallel algorithms for solving large-scale computational problems on supercomputing platforms.
4. Evaluate the performance of supercomputing systems using key metrics and analyze their scalability and efficiency.
5. Apply supercomputing techniques to real-world problems in AI, big data, and scientific research, and stay abreast of emerging trends in supercomputing.

Textbooks

1. "Parallel Programming in C with MPI and OpenMP" by Michael J. Quinn, McGraw-Hill Education, 2004.
2. "High-Performance Computing: Paradigm and Infrastructure" by Rajkumar Buyya, Springer, 2009.

Reference Books

1. "Supercomputing: Frontiers of Scientific Computing" by David E. Keyes, John Wiley & Sons, 2000.
2. "Introduction to High Performance Computing for Scientists and Engineers" by Georg Hager and Gerhard Wellein, CRC Press, 2011.
3. "GPU Computing Gems: Jade Edition" by Wen-mei Hwu, Elsevier, 2011.

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Open Elective II (Table II)

Open Elective -1: Technology Management

Course Objectives

1. To provide students with an understanding of the role of technology in modern organizations and its impact on business strategy and operations.
2. To explore the concepts of technology forecasting, selection, and the management of technology innovation processes.
3. To enable students to analyze the technological lifecycle and its implications on the sustainability and growth of organizations.
4. To introduce frameworks and tools for assessing and managing technology risks and technological change in rapidly evolving industries.
5. To equip students with the skills to manage technology-driven projects, implement technological innovations, and address challenges in technology integration.

Syllabus

Unit I: Introduction to Technology Management

Overview of technology management, its importance in business strategy, competitive advantage through technology, innovation and its impact on industries, technology-driven business transformation, organizational structure and technology alignment.

Unit II: Technology Forecasting and Innovation

Technology forecasting methods (trend extrapolation, cross-impact analysis, Delphi method), innovation types (incremental vs. disruptive), managing technology development and diffusion, creating innovation strategies, challenges in managing technological change, open innovation, and its role in modern enterprises.

Unit III: Technology Lifecycle and Commercialization

Technology lifecycle: from development to maturity and obsolescence, managing technology transitions, product life cycle (PLC) and its relation to technology management, commercialization strategies, managing patents and intellectual property (IP), R&D management.

Unit IV: Managing Technology Projects and Risks
Project management techniques for technology projects, risk assessment in technology management, evaluating technology investments, technology portfolio management, frameworks for decision-making, handling technological uncertainties, stakeholder management in technology-driven projects.
Unit V: Global Trends and Strategic Management of Technology
Global technology trends (IoT, AI, Big Data, Cloud Computing), managing technological collaboration and partnerships, strategic management of technology in multinational companies, managing technological disruptions, case studies of successful and failed technology strategies in various sectors (healthcare, AI, automotive).

Course Outcomes

1. Understand the role of technology in shaping business strategies and competitive advantages in modern enterprises.
2. Apply technology forecasting and innovation strategies to identify and manage emerging technological opportunities.
3. Manage the technology lifecycle from research and development (R&D) to commercialization and obsolescence.
4. Analyze and mitigate risks associated with technology investments, projects, and integration challenges.
5. Develop strategies for managing technology in a global business context, recognizing trends in technology-driven industries.

Textbooks

1. "Managing Innovation and Entrepreneurship" by Robert D. Hisrich, Michael Peters, and Dean Shepherd, McGraw-Hill Education, 2017.
2. "Technology Management: Global Business Strategy" by Richard C. Dorf, Wiley, 2008.

Reference Books

1. "The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail" by Clayton M. Christensen, Harvard Business Review Press, 1997.
2. "Strategic Management of Technology and Innovation" by Melissa A. Schilling, McGraw-Hill Education, 2017.
3. "Technology Strategy for Managers and Entrepreneurs" by Gregory G. Dess, G.T. Lumpkin, and A.E. Eisner, Pearson, 2006.

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Open Elective -2: **Decision Support and Executive Information System**

Course Objectives

1. To introduce the concepts of decision support systems (DSS) and executive information systems (EIS) and their applications in decision-making processes in organizations.
2. To explore the components, architectures, and functionalities of decision support and executive information systems.
3. To understand how data management, data warehousing, and business intelligence tools are integrated within DSS and EIS for efficient decision-making.
4. To develop skills in designing and implementing DSS and EIS in real-world organizational contexts.
5. To analyze and evaluate the impact of DSS and EIS on organizational performance, strategic decision-making, and business operations.

Syllabus

Unit I: Introduction to Decision Support Systems (DSS) and Executive Information Systems (EIS)

Overview of DSS and EIS, role of decision support systems in business, characteristics of decision-making, types of decisions (strategic, tactical, operational), components of DSS and EIS (data, models, and user interfaces), examples of DSS and EIS in various sectors.

Unit II: DSS Models and Tools

Decision models in DSS: optimization models, simulation models, and forecasting models, classification of DSS models (communication-driven, data-driven, document-driven, knowledge-driven), tools used in DSS (spreadsheets, databases, and expert systems), introduction to artificial intelligence in DSS.

Unit III: Data Management and Business Intelligence

Data warehousing concepts, data mining, and knowledge discovery techniques for DSS, integration of big data and analytics in decision support, business intelligence tools for decision-making, OLAP (Online Analytical Processing), data visualization for executives, dashboard design.

Unit IV: Executive Information Systems (EIS)

Characteristics of EIS, EIS architecture and components, role of EIS in strategic management, decision-making at the executive level, EIS tools for performance management (KPI, balanced scorecard), case studies on the use of EIS in different industries (healthcare, finance, manufacturing).

Unit V: Implementation and Evaluation of DSS and EIS

Implementation challenges of DSS and EIS, system design and integration, evaluation and assessment of DSS and EIS performance, security and ethical issues in decision support systems, real-world applications of DSS and EIS, future trends in DSS and EIS, emerging technologies like AI and cloud computing in DSS/EIS.

Course Outcomes

1. Understand the fundamental concepts and functions of decision support and executive information systems in business decision-making.
2. Apply various DSS models and tools for analyzing and solving complex business problems.
3. Design and implement data management strategies for effective integration of data warehouses and business intelligence tools within DSS and EIS.
4. Evaluate the effectiveness of executive information systems and understand their role in improving strategic decision-making.
5. Address real-world challenges in implementing and evaluating DSS and EIS and explore future trends and technologies in decision support systems.

Textbooks

1. "Decision Support and Business Intelligence Systems" by Efraim Turban, Ramesh Sharda, Dursun Delen, and David King, Pearson, 2018.
2. "Executive Information Systems: A Guide for Implementation" by L. L. Christopher, Springer, 2000.

Reference Books

1. "Decision Support Systems: Concepts and Resources for Managers" by Daniel J. Power, Greenwood Publishing Group, 2002.
2. "Business Intelligence: A Managerial Perspective on Analytics" by Ramesh Sharda, Dursun Delen, Efraim Turban, Pearson, 2017.
3. "Data Warehousing in the Real World: A Practical Guide for Building Integrated Information Applications" by Paulraj Ponniah, Addison-Wesley, 2001.

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Open Elective -3: **Managerial Skills**

Course Objectives

1. To introduce students to key managerial skills required for effective leadership, decision-making, and team management in technical environments.
2. To enhance students' ability to communicate effectively, both in writing and verbally, in a professional setting.
3. To develop critical thinking and problem-solving skills in real-world management situations.
4. To foster an understanding of organizational behavior and the role of managers in influencing culture, performance, and employee motivation.

5. To equip students with the skills to manage time, resources, and conflicts efficiently in diverse organizational contexts.

Syllabus

Unit I: Introduction to Managerial Skills
Overview of managerial skills, managerial roles and responsibilities, importance of technical, human, and conceptual skills, the role of managers in organizational success, leadership styles and traits, emotional intelligence in management.

Unit II: Communication Skills for Managers
Communication models and processes, importance of effective communication in management, verbal and non-verbal communication, business writing skills (emails, reports, proposals), presentation skills, communication barriers and strategies to overcome them, effective listening.

Unit III: Problem-Solving and Decision-Making
Steps in problem-solving and decision-making, decision-making tools and techniques (SWOT analysis, decision trees, cost-benefit analysis), critical thinking and creativity in problem-solving, decision-making in uncertain environments, managing ethical dilemmas.

Unit IV: Team Management and Leadership
Team dynamics and team-building strategies, managing diverse teams, conflict resolution techniques, leadership theories (transformational, transactional, servant leadership), motivation theories (Maslow, Herzberg, McGregor), decision-making in teams, delegation and empowerment.

Unit V: Time, Resource, and Conflict Management
Time management techniques (Pareto principle, Eisenhower matrix), prioritization of tasks, stress management, resource allocation, conflict management styles, handling workplace conflicts, negotiation skills, decision-making under pressure.

Course Outcomes

1. Demonstrate a comprehensive understanding of the key managerial skills required for success in any technical or business organization.
2. Apply effective communication strategies to enhance organizational collaboration and productivity.
3. Solve complex management problems using structured decision-making approaches and critical thinking.
4. Manage teams effectively by applying leadership and conflict resolution techniques to improve performance.
5. Utilize time and resource management techniques to increase productivity and handle challenges in a dynamic business environment.

Textbooks

1. "Management: Tasks, Responsibilities, Practices" by Peter F. Drucker, Harper & Row, 2001.

2. "Effective Communication for Managers" by M. S. Rao, Pearson Education, 2015.

Reference Books

1. "The 5th Discipline: The Art & Practice of The Learning Organization" by Peter M. Senge, Doubleday, 1990.
2. "Organizational Behavior: An Evidence-Based Approach" by Fred Luthans, McGraw-Hill Education, 2011.
3. "The Leadership Challenge: How to Make Extraordinary Things Happen in Organizations" by James M. Kouzes, Barry Z. Posner, Wiley, 2017.

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Open Elective -4: Information Theory and Coding

Degree Program: B.Tech (Honors) in Artificial Intelligence
Semester: 8th (Open Elective)

Course Objectives

1. To introduce the basic concepts of information theory, including entropy, information content, and the quantification of information.
2. To understand the principles behind various error detection and correction codes used in data transmission and storage.
3. To explore the concept of channel capacity and the relationship between information transmission rate and noise in communication channels.
4. To provide knowledge about the design and application of efficient coding schemes like Huffman coding, cyclic codes, and Reed-Solomon codes.
5. To develop an understanding of the mathematical foundations of coding theory and its applications in error correction and data compression.

Syllabus

Unit I: Basics of Information Theory
Introduction to information theory, entropy as a measure of information, properties of entropy, joint and conditional entropy, mutual information, and redundancy, the source coding theorem, Shannon's first and second theorems, information rate and capacity of discrete sources.
Unit II: Channel Capacity and Noisy Channels
The noisy channel model, channel capacity, Shannon-Hartley theorem, bandwidth and power limitations, error probability and its relationship with channel capacity, capacity of discrete memoryless channels, capacity of binary symmetric channels.
Unit III: Source Coding Techniques
Introduction to source coding, optimal source coding, Huffman coding algorithm,

arithmetic coding, Lempel-Ziv coding, data compression techniques, lossless and lossy data compression.

Unit IV: Error Detection and Correction

Linear block codes, parity-check codes, Hamming codes, Cyclic codes, Golay codes, Reed-Solomon codes, convolutional codes, error correction and detection performance analysis, code efficiency, syndrome decoding.

Unit V: Applications of Coding Theory

Applications of coding in data transmission (modulation, coding, and decoding), applications in storage systems, error correction in satellite communication, cryptography and coding, turbo codes, LDPC (Low-Density Parity-Check) codes, and modern coding techniques in wireless communication.

Course Outcomes

1. Understand the core concepts of information theory and their applications in data communication and storage systems.
2. Apply entropy and mutual information concepts to solve practical problems in data compression and transmission.
3. Analyze the performance of different coding schemes for error detection and correction in noisy communication channels.
4. Design and implement source and channel coding algorithms such as Huffman coding and Reed-Solomon codes.
5. Evaluate the effectiveness of various error correction techniques in practical communication systems and storage applications.

Textbooks

1. "Elements of Information Theory" by Thomas M. Cover and Joy A. Thomas, Wiley, 2nd Edition, 2006.
2. "Error Control Coding: Fundamentals and Applications" by Shu Lin and Daniel J. Costello, Pearson, 2nd Edition, 2004.

Reference Books

1. "Information Theory, Inference, and Learning Algorithms" by David J.C. MacKay, Cambridge University Press, 2003.
2. "Introduction to Coding Theory" by Ron Roth, Cambridge University Press, 2nd Edition, 2006.
3. "Fundamentals of Error-Correcting Codes" by W. Cary Huffman and Vera Pless, Cambridge University Press, 2003.

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LAB

1. Cloud Computing LAB

1. **Experiment 1: Setting Up a Virtual Machine in a Cloud Environment**
   In this experiment, students will learn to understand the basics of cloud computing by setting up and configuring a virtual machine on a cloud platform such as AWS, Google Cloud, or Microsoft Azure.
2. **Experiment 2: Deploying a Web Application on a Cloud Server**
   This experiment enables students to deploy a basic web application on a cloud server using services like AWS EC2, where they will practice deploying applications on the cloud infrastructure.
3. **Experiment 3: Working with Cloud Storage Services**
   Students will explore cloud storage services such as AWS S3, Google Cloud Storage, or Microsoft Azure Blob Storage to store and retrieve data, learning how to manage cloud-based data storage.
4. **Experiment 4: Setting Up and Configuring Cloud Networking**
   In this experiment, students will configure and manage networking services in the cloud, such as creating Virtual Private Cloud (VPC) and subnets on cloud platforms like AWS, Google Cloud, or Azure.
5. **Experiment 5: Using Cloud Functions for Serverless Computing**
   This experiment provides students with hands-on experience in serverless computing by creating a serverless function using AWS Lambda, Google Cloud Functions, or Azure Functions, enabling them to understand the serverless paradigm.
6. **Experiment 6: Cloud Load Balancing and Auto Scaling**
   In this experiment, students will configure load balancing and auto-scaling in the cloud environment to handle varying traffic loads efficiently, using tools such as AWS Elastic Load Balancing (ELB) and Google Cloud Load Balancer.
7. **Experiment 7: Cloud Databases and Data Management**
   This experiment introduces students to setting up and managing cloud-based relational databases such as AWS RDS or Google Cloud SQL, enabling them to practice database management in a cloud environment.
8. **Experiment 8: Cloud Security: Identity and Access Management (IAM)**
   In this experiment, students will learn to manage users, permissions, and security policies in the cloud using Identity and Access Management (IAM) tools from platforms like AWS IAM, Google Cloud IAM, or Azure Active Directory.
9. **Experiment 9: Implementing Cloud Monitoring and Logging**
   This experiment focuses on cloud monitoring services such as AWS CloudWatch, Google Stackdriver, or Azure Monitor, where students will track resources and application performance in a cloud environment.
10. **Experiment 10: Setting Up Cloud-based CI/CD Pipeline**
    In this experiment, students will set up a Continuous Integration/Continuous Deployment (CI/CD) pipeline using cloud services like AWS CodePipeline,

Google Cloud Build, or Jenkins on the cloud, providing hands-on experience with cloud-based automation tools.

2. Deep Learning LAB

1. **Experiment 1: Introduction to Neural Networks and Training a Simple Perceptron**
   In this experiment, students will understand the basics of neural networks by training a simple perceptron to classify basic linearly separable data.
2. **Experiment 2: Implementing Feedforward Neural Networks (FNN)**
   This experiment allows students to implement and train a feedforward neural network (FNN) for a classification task using backpropagation.
3. **Experiment 3: Convolutional Neural Networks (CNN) for Image Classification**
   In this experiment, students will implement a Convolutional Neural Network (CNN) to classify images from the CIFAR-10 dataset.
4. **Experiment 4: Implementing a Recurrent Neural Network (RNN) for Sequence Prediction**
   Students will implement and train a Recurrent Neural Network (RNN) for sequence prediction tasks, such as time series forecasting, in this experiment.
5. **Experiment 5: Long Short-Term Memory (LSTM) Network for Sentiment Analysis**
   This experiment involves implementing an LSTM-based model for sentiment analysis using a text dataset, allowing students to explore sequence models.
6. **Experiment 6: Generative Adversarial Networks (GANs) for Image Generation**
   Students will understand and implement a Generative Adversarial Network (GAN) for generating new images similar to a training set, such as the MNIST dataset.
7. **Experiment 7: Transfer Learning for Image Classification with Pre-trained Models**
   In this experiment, students will apply transfer learning techniques using pre-trained models like VGG16 or ResNet for a new image classification task.
8. **Experiment 8: Autoencoders for Data Compression and Denoising**
   This experiment will have students implement autoencoders for tasks like image denoising and data compression, exploring how these models learn efficient representations of input data.
9. **Experiment 9: Hyperparameter Tuning for Deep Learning Models**
   Students will explore the impact of various hyperparameters on the performance of a deep learning model and learn to fine-tune them using grid search or random search.
10. **Experiment 10: Model Evaluation and Deployment for Real-World Applications**
    In this experiment, students will evaluate the performance of a deep learning model on test data and deploy it using Flask or FastAPI for real-time predictions.

3. **Major Project**

In the major project for BTech (Honors) AI and Data Science students, it is essential to apply the principles and techniques of Artificial Intelligence (AI) and Data Science (DS) to real-world problems. Students are encouraged to explore advanced AI concepts such as machine learning, deep learning, natural language processing, computer vision, and data analytics. They should focus on the practical implementation of these concepts, including data preprocessing, model development, and performance evaluation. The project should demonstrate the ability to solve complex problems using AI and DS methodologies, showcasing innovation and technical expertise. This project provides students with the opportunity to contribute to current technological advancements while gaining valuable hands-on experience.

4. **Indian Constitution**

Unit 1: Historical Background and Making of the Indian Constitution

- Evolution of the Indian Constitution: From the British colonial period to independence.
- Key events and documents: Government of India Acts (1919, 1935), the Cabinet Mission, and the Constituent Assembly.
- Role of the Constituent Assembly and prominent leaders: Dr. B.R. Ambedkar, Jawaharlal Nehru, Sardar Patel.
- Fundamental features and objectives of the Indian Constitution.

Unit 2: Fundamental Rights, Duties, and Directive Principles

- Fundamental Rights: Types, significance, and limitations (Right to Equality, Right to Freedom, etc.).
- Fundamental Duties of citizens as enshrined in the Constitution.
- Directive Principles of State Policy: Nature, objectives, and role in guiding state policy.
- Relationship between Fundamental Rights and Directive Principles.

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